Mentoring Team Conflicts in Capstone Design: Problems and Solutions

Dr. Marie C Paretti, Virginia Tech

Marie C. Paretti is an Associate Professor of Engineering Education at Virginia Tech, where she co-directs the Virginia Tech Engineering Communications Center (VTECC). Her research focuses on communication and teamwork in engineering, design education, and engineering identity. She was awarded a CAREER grant from NSF to study expert teaching practices in capstone design courses nationwide, and is co-PI on NSF . Her work includes studies on the teaching and learning of communication, the effects of curriculum on design cognition, the effects of differing design pedagogies on retention and motivation, the dynamics of cross-disciplinary collaboration in both academic and industry design environments, and gender and identity in engineering.

Dr. James J. Pembridge, Embry-Riddle Aeronautical Univ., Daytona Beach

James J. Pembridge is an Assistant Professor in the Freshman Engineering Department at Embry-Riddle Aeronautical University. He earned a B.S. in Aerospace Engineering, M.A. Education in Curriculum and Instruction, and Ph.D. in Engineering Education from Virginia Tech. His research has focused on mentoring as pedagogy for project-based courses and understanding the adult learning characteristics of undergraduate students.

Mr. Stephen C Brozina, Virginia Tech
Mr. Benjamin David Lutz, Virginia Tech
Miss Jintana Nina Phanthanousy, Embry-Riddle Aeronautical University

Nina Phanthanousy is a master's candidate at Embry-Riddle Aeronautical University pursuing Mechanical Engineering. She is currently a graduate assistant for the College of Engineering where she helps professors gather data for engineering education research and helps administer ERAU's women's engineering mentoring program; FIRST (Female Initiatives: Reaching Success Together).

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Introduction

Teaming is ubiquitous in design education, yet many project mentors have little or no formal training in teamwork or in mentoring teams, and have learned primarily through experience. As a result, issues associated with teaching teamwork or addressing team dynamics are often challenging for design faculty. Most capstone projects involve multi-person teams, and teamwork is often considered a critical outcome in design courses, but in a recent national survey, fewer than 50% of capstone faculty responding included instruction in teamwork as a key course component [1]. Moreover, as the results from a recent Capstone Design Conference indicate, faculty often struggle with a range of issues related to teaming, including team formation, the balance between evaluating overall product quality and evaluating team processes, and the relative importance of teamwork versus technical skills[2]. Finally, a recent study of faculty beliefs and practices around teaching teamwork and communication suggests that faculty often rely on abstract or ad hoc approaches to teamwork, treat teamwork as something students simply learn "by doing," and often avoid specific instruction in this critical skill[3].

Despite these gaps in teaching teamwork, the skill itself consistently emerges among the top skills requested by employers, and team issues surface repeatedly in design courses when instructors describe their teaching practices. The lack of readily available concrete strategies[3] in particular points to the need for more work in understanding what kinds of team issues faculty face when mentoring design teams, what approaches are available for addressing those issues, and what types of faculty development and support would be beneficial.

In this paper, we begin to address design faculty's need for practice-oriented approaches to mentoring and managing design teams by focusing on team conflicts. We draw on interviews with capstone faculty from a diverse set of institutions and a range of disciplines to categorize both common types of conflict that teams experience and approaches to managing those conflicts. Specifically, we address two questions to provide a basis for helping capstone faculty effectively manage design team dynamics:

1. What types of team issues do capstone faculty perceive as salient in design teams?

2. How do faculty choose to intervene when addressing these issues?

Methods

Sample

Data for this study is drawn from interviews conducted with faculty who had responded to a survey regarding teaching practices and beliefs in capstone design[1, 4]. Interview participants were selected from the survey respondents using a stratified purposeful sample[5] based on three criteria: role, expertise level, and discipline. Selected participant provide a representative sample of self-reported roles (coordinator, instructor, and advisor), expertise levels (defined as a combination of teaching experience, industry work experience, and recognition of scholarly

activities[6]), and disciplines (chemical, civil/environmental, electrical/computer, mechanical/aerospace, and industrial). Secondary selection criteria include representation across rank (assistant, associate, and full professor) and institution (e.g. private/public and size).

A total of 42 interviews were conducted during the summer of 2010, predominantly by phone. For this study, data analysis considered seventeen of the interviews: all ten interviews with faculty who scored high on the expertise scale and all seven interviews with faculty who scored low on the expertise scale. All data collection was conducted with the approval of Virginia Tech's Institutional Review Board (IRB 08-465).

Protocol

The interviews were conducted using the critical decision method (CDM), which was designed to model expert decision-making in ambiguous, non-rote tasks associated with high time-pressure situations with limited opportunity for deliberation[7] This method has been applied in a variety of situations, including fire ground command decisions and other emergency incidents, as well as in engineering education to identify how engineering educators take student differences into account[7, 8]. Within engineering education, the method has been used successfully by Sattler and Turns to model faculty decision processes[8, 9]. Although capstone courses do not typically present the kind of high-pressure situations for which CDM was originally designed, it does represent an ambiguous, ill-defined environment in which faculty encounter a range of projects, personalities, and skill levels, and must often act in the moment to make quick decisions on class management and pedagogical approaches throughout a class period or team meeting[10, 11]. Given its successful use in engineering education by Sattler and Turns, CDM was used in the study to solicit details of faculty practices that address both content and tacit knowledge within a given situation, and explore how the knowledge was used to address the situation[7].

CDM employs a semi-structured, case based interview protocol in which the interviewer guides the participant in selecting an incident, providing a detailed account of what happened, identifying the critical decision(s), and probing for details to understand why and how the participant selected the particular course of action[7]. The semi-structured nature of the protocol allows the interviewer to pursue additional details regarding the case as needed. In this study, the CDM component of the interview was embedded within a set of more generalized questions designed to provide a more comprehensive picture of each participant's approach to the capstone design course. This approach thus elicited both general and concrete descriptions of participants' capstone courses and their approach to teaching. It incorporated sequencing of the questions to provide context and elicit recall of memories associated within the context [5]. The complete protocol is included in Appendix A.

Analysis

The data was coded using an iterative thematic analysis. The second and last authors performed an initial round of coding on the ten high interviews. The first and second authors reviewed the initial pass and refined the code book to identify the salient team issues faculty encountered and the approaches they employed in addressing the problems. This codebook was then given to the third and fourth authors, who applied it independently to a subset of five interviews; these researchers then met with the first author and the coding process was arbitrated to reach a final

agreement on the working definitions of the codebook and to ensure consistency across coders. Each coder then analyzed a subset of the interviews, and the final coding was reviewed by the first author during data interpretation.

Results

Overview

Across the interviews, issues associated with team dynamics emerged not only in the CDM component of the interview, where participants were asked to describe a specific issue confronting a team, but across the interviews as faculty described their general approach to teaching the class and their most important work as a design educator. Notably, although the interview protocol allowed faculty to select an incident in which a team experienced difficulty relating to content knowledge, design ability, or team issues, almost all faculty framed the issue in terms of team dynamics – even when a component of the conflict may have involved lack of technical or design competence. In the seventeen interviews considered for this analysis, fifteen directly and explicitly described team conflict issues. The two faculty who did not describe team issues were both low on the expertise score, and one explicitly stated that they intentionally did not ever intervene in team dynamics. For most faculty, however, team dynamics emerged as a prominent point of mentoring and educating design teams.

Team Issues

Not surprisingly, the teaming issues capstone faculty identified fall into five basic categories, summarized in Table 1:

Table 1: Teaming Issues

Issue	**Definition**
Design Decision	Conflicts or problems making decisions related to the project itself, including scope, criteria, alternative selection.
Workload imbalance	Conflicts linked to a team member who takes on too much or too little responsibility.
Capability deficiency	A team member who cannot effectively do the work – i.e. who does not have the requisite competence or skill.
Personality	Team members who cannot get along.
Miscommunication	Conflicts that arise from misunderstandings, failure to provide information to one another, or failure to understand one another.

Importantly, although each of these issues emerge as distinct within the interviews, most interview participants described needing to address multiple categories. Only 2 participants described only a single issue – and both referred to capability deficiency. In contrast, 5 of the participants described at least four different team issues, and often problems in one area led to problems in other areas. Capability deficiencies associated with underperforming team members

were most common, cited by 14 of the participants, followed by design issues (cited by 11 participants) and workload imbalances (cited by 9 participants). Personality conflicts and miscommunication were cited by fewer than half of the participants, though these issues still emerged multiple times across the interviews. Notably, high-expertise and low-expertise faculty were equally likely to experience each of the issues.

Interventions

To address the second question, in this study we focused on where the faculty member intervened, since in general decisions about the site of the intervention precede the intervention itself. Across the issues, three possible approaches emerged:

- *Whole team*: The instructor meets with the whole team to address the conflict as a group.
- *Individual Team Member(s):* The instructor intervenes with only the member(s) of the team at the heart of the problem.
- *Team mediator*: The instructor trains one or more members of the team to handle the problem rather than intervening directly.

Interventions with the entire team or with the team member(s) at the heart of the problem were the most common approaches, and these interventions generally took the form of direct instruction and/or walking the team through the resolution process, with specific suggestions for improvement. The decision process regarding where to intervene often depended on both the nature of the problem itself and the faculty member's own level of confidence in and ability with the intervention process.

The clearest pattern, as one might expect, was that faculty most frequently addressed conflicts involving design decisions with the entire team, helping the team walk through the decision-making process and providing probing questions, guidance via experience (i.e. recounting approaches the faculty member uses in his/her own work), or direct instruction. Conflicts associated with miscommunication, though rarely identified in the interviews, also followed this approach, though if the miscommunication involved only a subset of the team, the instructor would target only those students.

With respect to the other team issues that arose, the responses were more variable. Workload imbalances, for example, were sometimes addressed with the whole team, in which the instructor helped the team strategize an effective project management plan to more evenly balance the workload. In other cases, though, the instructor addressed imbalances by dealing directly with the team member who was taking too much or too little responsibility, or by working with one member of the team (the team leader or project manager) to develop strategies for addressing the problem within the team.

Capability deficiencies showed a similar variability. At times, particularly when more than one member of the team appeared to be struggling with a task, the instructor addressed the team as a whole or, in some cases, directed the whole team to another expert for help. In other cases, particularly when one student was notably underperforming as a result of a lack of skills, the

intervention focused on one-on-one tutoring with the struggling student to help him or her getting a better grasp on the issue.

Most variable were the approaches to personality conflicts, which were the only team issue that was addressed in all three ways across the interview participants. That is, sometimes the instructor choose to intervene with the entire team, sometimes with only the individual(s) at the heart of the conflict, and sometimes by training one member of the team in strategies for managing the conflict.

Notably, interventions in which the instructor mentored another member of the team through the conflict resolution process were far less frequent. Only 3 high-expertise instructors and 1 low-expertise took this approach, always either in cases of workload imbalances or personality conflicts.

Discussion and Conclusions

In one sense, the findings from this preliminary analysis are not surprising; most capstone instructors can readily recognize the conflict categories as well as the possible approaches to addressing those conflicts. Delineating them, however, serves to illuminate more specifically the kind of faculty development efforts that may be needed to support new design faculty and enhance the work of more experienced faculty; given the persistent hesitation on the part of a number of faculty when it comes to addressing team conflicts[2], faculty clearly need support in this area. The analysis presented here suggests several core areas for short workshops, training materials, or easily accessible web resources:

- *Group decision making*: The emergence of conflicts regarding design decisions highlights the need for capstone faculty to have the skills needed to walk a team through critical decisions regarding factors such as project scope, weighting of decision matrices, evaluation of alternatives, and design selection. Importantly, capstone faculty need the skills not simply to lead a team through such decisions, but to teach the team how to work through that process independently, which suggests the need for concrete, actionable steps that faculty can pass on to student teams.

- *Project management and work distribution:* A number of team conflicts address issues of workload imbalance as members of a design team either slack off or seek control of the project. Intervening in these issues again requires faculty to teach the team members how to approach these management issues, including how to help team members honestly and realistically assess the time and effort they have available for the project (and, correspondingly, how to assign credit for work if the team chooses an unequal distribution), how to respond to and adjust for delays from one or more team members, how to communicate the status of project tasks, and how to hold one another accountable for work. Such skills are not easy, even for trained project managers, but providing capstone faculty with tools to facility this work can make a substantial contribution to their ability to help team members develop their collaboration skills.

- *Generalized conflict resolution strategies:* Conflicts surrounding personality issues in particular, but also those around group decision making, often require specific skills in

conflict negotiation. And while web sites abound to provide faculty with specific strategies (understanding styles for conflict resolution, active listening, creating safe spaces, identifying core facts, separating people from problems, striving for win-win solutions, etc.), enacting such approaches often requires practice and mentoring – something faculty with industry experience often bring, but which may be less available for individuals with academic career paths.

The topics noted above point to the need for workshops and resources that support faculty's own ability to manage and negotiate conflict. But perhaps even more most importantly, the limited extent to which capstone faculty in this study trained individuals on the team to resolve the conflict themselves also points to the need to help faculty learn to teach these skills – an approach which includes providing faculty with resources that they first understand themselves, but second, can explain to and model for student design teams.

Interestingly, the analysis of approaches to team problems showed little evidence of difference among capstone faculty based on the expertise measure used in this project. As noted earlier, the expertise score, adapted from expertise models used in K-12 teaching, was based on a combination of teaching experience, industry experience, and scholarly activity[12]. This lack of differentiation points to the limits of the expertise measure and the need to more fully explore factors associated with expert teaching in capstone courses. The initial measure, for example, provides no weighting of the constructs, but it may be that certain factors such as industry experience play a larger role in the ability to teach teamwork. More work is clearly need to better understand the kinds of preparation that supports excellence in capstone teaching.

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Appendix A: Interview Protocol

1. Describe your approach to teaching the capstone design course.

2. Describe a situation where a design team was having difficulty due to a lack of content knowledge, design knowledge, or teaming.

Probes

- What indicated this was a problem?
- How did you solve the problem?
- Were you reminded of any previous experiences?
- What were your goals?
- What options did you consider?
- How did you select/not select this option?
- What experience or training aided you in this decision?
- What training could have helped?
- How much time pressure was involved in making the decision?
- How would you summarize the situation?
- If a key factor had been different, what difference would it have made?
- Is this situation typical with most students/teams?

3. What are the most important things you do as a design educator?

4. Is there anything else that you would like to add to the interview that we may not have covered